PRELIMINARY STUDY CONCERNING CLIMATIC CONDITIONS INFLUENCE FROM WINTER SEASON ON MAIZE LEAF WEEVIL (*TANYMECUS DILATICOLLIS* GYLL) ATTACK

Emil GEORGESCU[1], Radu GARGARITĂ[1], Lidia CANĂ [1], Luxita RASNOVEANU[2]

email: emilgeorgescu2013@gmail.com

Abstract

Maize leaf weevil (*Tanymecus dilaticollis* Gyll) is the main pest of the maize crops in south and south-east of the Romania. In this paper, authors collective present preliminary results of a study concerning influence of the winter conditions on attack of *T. dilaticollis*. It has analyzed the temperatures from winter (December-February) and attack intensity of the studied pest at maize untreated plants, in spring period. Pest attack was rated when maize plants were in four leaf stage (BBCH 14) on a scale from 1 (plant not attacked) to 9 (plants complete destroyed). During the time, at NARDI Fundulea, winters were variable, from one year to another. The attack of *T. dilaticollis* at maize untreated plants registered in springs followed after cold winters was low in 1999 (I=4.3), high in 2003 and 2012 (I=7.8 and 6.7) and moderate in 2011 (I=5.8). The attack registered in springs followed after warm winters was high in 1989 (I=9.0) and 1995 (I=8.4), while in year 2001, followed after one of the warmest wither of the century, the attack of the maize leaf weevil at untreated plants was low (I=4.8). There were no correlation between temperatures registered during winter season and attack of *T. dilaticollis* at maize plants registered in spring. The most important for pest attack are the climatic conditions from period when maize are in first vegetation stages (BBCH 10-14). Results of the study effectuated at NARDI Fundulea make in evidence that low rainfalls level and high temperatures from this period favor pest attack.

Key words: winter, maize, pest, attack, temperature

Cultivated on a surface higher then 2.4 million hectares, maize is one of the most important cereals in Romania (MADR data, 2015). According Eurostat database (2015), Romania occupy first place in EU on maize area, but average production per hectare was low, comparative with countries from West Europe. Pest attack is one of the main reasons for maize yield losses. Trotus E. *et al.* (2011) mentioned that, in some years, only because of the pest attack, maize yield losses can arrive at 23%. In climatic conditions of the Romania, maize is attacked by different pests, such as wire worms (*Agriotes* spp.), maize leaf weevil (*Tanymecus dilaticollis*), european corn borer (*Ostrinia nubilalis*), western corn rootworm (*Diabrotica virgifera virgifera*), corn earworm (*Helicoverpa armigera* sin. *Chloridea obsolete*) and other species from Noctuidae family (Popov C. and Barbulescu A., 2007; Rosca I. et Istrate R., 2009; Trotus E. *et al.*, 2013). In south and south-east of the Romania, maize leaf weevil (*Tanymecus dilaticollis*) is the main pest of the maize crops (Paulian F. *et al.*, 1969; Popov C., 2002; Cristea M. *et al.*, 2004). Data from literature suggested that, after 2000, every year, around 1 million hectares with maize are attacked in spring by maize leaf weevil (Barbulescu A., 2001; Popov C. *et al.*, 2002, 2003, 2004, 2005). Recent researches make in evidence important attack of the *T. dilaticollis* at the maize plants, in areas considered until now, unfavorable for this pest activity, such as Transylvania (Antonie I. *et al.*, 2012). Possible occurrence of the insect in northern areas is because of the climate changes, especially global warming (Čamprag D., 2011; Olesen J. E., 2011). Rosenzweig C. *et al.* (2001) mentioned that climate changes such as global warming and increasing of extreme weather phenomenon may produce changes in dynamics of the main crop pests, exacerbating yield losses. Many pests can be favored by climate changes such as increasing of the temperature in northern latitudes (Čamprag D., 2007; Gregory *et al.*, 2009; Karuppaiah V. and Sujayanad G. K., 2012; Daniel P. B. *et al.*, 2013; Ju H. *et al.*, 2013). According Diffenbaugh N. S. *et al.* (2008), the climate changes will increase the prevalence of insect pests in many agro-ecosystems, also in maize agro-ecosystems too. Warm winters may affect insect

[1] NARDI, Fundulea
[2] ARDS, Braila and „Dunarea de Jos" University, Galati, Faculty of Engineering and Agronomy, Braila.

populations, by extending the growing season, altering the timing of emergence from overwintering sites, reducing overwintering mortality or increasing grow and development rate (Battisti A. *et al.,* 2005; Wolfe D. W. *et al.,* 2007; Oakley J. N., 2008; Hakala K. *et al.,* 2011; Maxem A., 2013). Maize leaf weevil overwinters like adult in soil at 40-60 cm deep, sometime at 100 cm (Paulian F., 1972). Same author mentioned that, when soil temperature, in place where *T. dilaticollis* overwinter, arrive at +4 °C, the insects start migrating to soil surface. When soil temperature arrives at +9 °C, usually at the end of March or beginning of April, insects appear at soil surface. The insects are very active at temperatures higher then +18 °C, at the soil surface, usually this period coincide when maize plants are in first vegetation stages (Rosca I. and Istrate R., 2009). In case of higher pest attack, maize plants can be total damaged and must be sowing again (Čamprag D. et al., 1969; Barbulescu A. *et al.,* 2001). Previous reports make in evidence that average maize yield losses, as result of *T. dialtiocllis* attack, can arrive at 34% (Paulian F. *et al.,* 1974). Later reports, mentioned that in case of plants emerged from untreated seeds, the damages because of the *T. dilaticollis* attack ranged between 10 and 25% and, in some cases, at 100% (Popov C. et al., 2007). In last three years, in journals for farmers there were several reports about maize losses in the spring period, as result of the *T. dilaticollis* attack (Rich Harvests, 2013, 2014; Plants Health, 2015). In Romania there were make several researches concerning influence of the climatic conditions from spring periods on maize leaf weevil attack. High temperatures and low rainfalls level from the last 10 days of April and first 20 days of May, period that coincide with first vegetation stages of the maize plants, favorite *T. dilaticollis* attack (Popov *et al.,* 2006). Same author mentioned that In case of low temperatures and high rainfall level, in period mentioned above, *T. dilaticollis* attack is low as result of low insect activity. Recent studies make in evidence that even if the overall climatic conditions registered in April and May seems to be unfavorable for the insect activity, daily rainfalls and temperatures distributions correlated with plant emergence data can favorite *T. dilaticollis* attack at maize plants (Georgescu E. *et al.,* 2014, 2015). In this paper, authors collective present preliminary results of a study concerning influence of the winter conditions on maize leaf weevil (*Tanymecus dilaticollis*) attack at untreated maize plants, in south-east of Romania.

MATERIAL AND METHOD

The experiences were carried out at Plant and Environment Protection Collective from National Agricultural Research and Development Institute (NARDI) Fundulea, Calarasi County (latitude: 44,3; longitude: 24,1; alt.: 68 m), Romania.

Maize plants were sowed during the third decade of April, each year. In some years, as results of the climatic conditions, especially rainfalls from the April, maize crop were sowed in first 10 days of May.

Attack intensity is evaluated when the maize plants arrive in four leaf stage (BBCH 14), according a scale from 1 to 9, elaborated and improved by Paulian F. (1972), as follows: note 1-plant not attacked; note 2-plant with 2-3 simple bites on the leaf edge; note 3-plants with bites or clips on all leafs edge; note 4-plants with leafs chafed in proportion of 25%; note 5-plants with leafs chafed in proportion of 50%; note 6-plants with leafs chafed in proportion of 75%; note 7-plants with leafs chafed almost at the level of the stem; note 8-plants with leafs completely chafed and beginning of the stem destroyed; note 9-plants destroyed, with stem chafed close to soil level.

For winter period it has analyzed historical data provided by meteorological station of NARDI Fundulea. From each winter season, it has taken in consideration average month temperature from December to February. Also it has analyzed temperature and rainfalls data from period when maize are in first vegetation stages, from plant emergence (BBCH 10) until four leaf stage (BBCH 14). This period coincide with last 10 days of April and first 20 days of May, at each year taken in study.

The correlations and statistical analyze were made, using Microsoft Excel, version 2003 and ARM, version 8.5.0 software.

RESULTS AND DISCUSSIONS

Data from *table 1* demonstrate high variability of the winter conditions at NARDI Fundulea, from one year to another. Average temperatures registered in winter season 1983-1984 were over multiyear average for this season. Attack of the *T. dilaticollis* registered in spring period of 1984 was low. Temperatures registered in winter season 1984-1985 were below multiyear average, especially because of low average temperatures registered in January and February, 1985. However the attack of the maize leaf weevil registered at untreated maize in spring period of 1985, on a scale from 1 to 9 was of 8.9 and almost all untreated plants was destroyed. Winters with average temperatures below multiyear averages it has registered in seasons 1993-1994, 1998-1999, 2002-2003, 2010-2011 and 2011-2012. Attack of

T. dilaticollis at maize untreated plants registered in springs followed after cold winters was low in case of year 1999 (I=4.3), high in case of years 2003 and 2012 (I=7.8 and 6.7) and moderate in case of year 2011. From same table 1 it has ascertained that warm winters, with temperatures higher then multiyear average for this season, it has registered in periods 1988-1989, 1994-1995 or 2000-2001. During season 1988-1989, only in January, average temperatures was negative (-1.0 °C). In the other two winter months, average temperature was positive. During warm winter seasons of 1994-1995 and 2000-2001, average temperatures registered between December and February ware positive. Also, winter registered in season 2000-2001 it has considered one of the warmest winter from last century (Luterbacher J. *et al.*, 2004). Attack of *T. dilaticollis* at maize untreated plants in springs followed after warm winter mentioned before was variable. The attack registered in spring of the year 1989 was maximum, all untreated plants was destroyed while attack registered in spring of the year 1995 was high (I=8.4), more then 90% of untreated plants was destroyed. However in spring period of the year 2001, followed after one of the warmest wither of the century (2000-2001), the attack of the maize leaf weevil at untreated plants presented low values (I=4.8). In last three years taken in study (2012-2015), average temperatures registered during winter seasons, were higher comparative with multiyear averages.

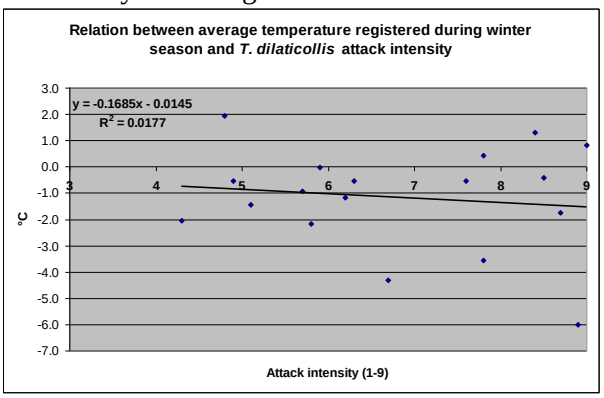

Figure 1 **Relation between average temperature registered during winter season and *T. dilaticollis* attack intensity**

Average temperature registered in December, 2012 was lower comparative with multiyear average while temperatures registered in January and February, 2013, were higher then multiyear average. In next winter season, average temperature registered in December was considered normal for that period, while temperatures registered in January and February, 2014 was higher then multiyear averages. In winter season, 2014-2015, all months average temperatures (December-February) was higher then multiyear average for this period, even if in January, 2015 average temperature was negative (-1.4 °C). In the conditions of warmer winters registered in last years, at NARDI Fundulea and south-east of the Romania, attack of the *T. dilaticollis* at maize untreated plants registered in spring period was variable. In spring of the year 2013, attack intensity of maize leaf weevil at untreated plant was of 5.9, in spring of the year 2014 attack intensity of this pest at untreated plant was of 6.3 while, one year later, the attack was high (I=7.8).

There were no correlations between temperatures registered during winter season and attack of *T. dilaticollis* at maize plants registered in spring (*figure 1*). After cold winters, with temperatures below multiyear averages it has registered, both, high and low attack of the maize leaf weevil, during spring. Also, after warm winters, in next springs the attack of this pest was variable. These results suggest that temperatures registered in winter season have no influence on the insect behavior in the next spring. A possible explication for this is that insect overwinter like adult in soil at 40 cm deep and some time, at 60-100 cm Paulian F., 1972).

At NARDI Fundulea it has studied influence of both, temperatures and rainfalls registered in spring period concerning *T. dilaticollis* attack, when maize plants are in first vegetation stages from emergence until four leaf stage (BBCH 10-14). In this period maize plants are the most sensitive at this pest attack (Paulian F. et al., 1969; Barbulescu A. et al., 2001).

Historical data, presented in table 2 demonstrate that in years with low rainfalls level, below multiyear average, registered in period when maize plants are in first vegetation stages (last 10 days of April-first 20 days of May), the attack of maize leaf weevil at untreated plants was high. In most of the cases attacked plants was destroyed.

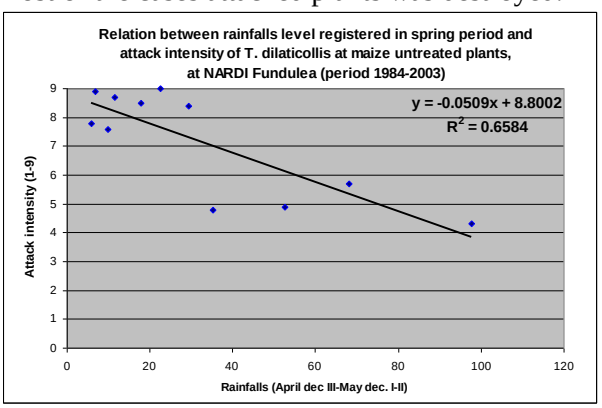

Figure 2 **Relation between rainfalls level registered in spring period and attack intensity of *T. dilaticollis* at maize untreated plants, at NARDI Fundulea (period 1984-2003)**

Contrarily, in years with high rainfalls level, over multiyear averages, registered in spring period, when maize plants are in first vegetation stages the attack of *T. dilaticollis* at untreated plants was low or moderate. Between rainfalls registered in spring period and maize leaf weevil attack was negative correlation (*figure 2*). In last years there was not the same correlation between rainfalls level registered in spring and the attack of *Tanymecus*

Table 1

Temperatures registered in winter season (December-February), comparative with multiyear average, at NARDI Fundulea

Season	Atack intensity (1-9)	Saved plants (%)	Temperature (°C) Curent year			Winter average temperature (Dec.-Feb.) (°C)	Deviation (°C)
			Month				
			Dec.	Ian.	Feb.		
1983-1984	4.9	72.0	-1.5	0.5	-0.6	**-0.5**	**+0.4**
1984-1985	8.9	2.0	-1.1	-7.5	-9.4	**-6.0**	**-5.0**
1985-1986	8.5	12.0	1.4	0.6	-3.2	**-0.4**	**+0.6**
1988-1989	9.0	0	0.5	-1.0	3.0	**0.8**	**+1.8**
1993-1994	8.7	10.0	-1.8	-1.7	-1.9	**-1.8**	**-0.8**
1994-1995	8.4	9.0	0.7	2.2	1.0	**1.3**	**+2.3**
1998-1999	4.3	90.0	-6.0	-0.5	0.4	**-2.0**	**-1.0**
1999-2000	5.7	67.0	1.5	-5.7	1.4	**-0.9**	**+0.1**
2000-2001	4.8	86.0	2.7	0.9	2.2	**1.9**	**+2.9**
2001-2002	7.6	20.0	-4.2	-3.0	5.6	**-0.5**	**+0.5**
2002-2003	7.8	43.0	-4.7	-1.8	-4.2	**-3.6**	**-2.6**
2003-2004	6.2	74.0	-0.1	-4.2	0.8	**-1.2**	**-0.2**
2009-2010	5.1	85.5	0.5	-3.9	-0.9	**-1.4**	**-0.4**
2010-2011	5.8	79.3	-0.7	-3.2	-2.6	**-2.2**	**-1.2**
2011-2012	6.7	68.2	2.8	-1.4	-7.2	**-4.3**	**-3.3**
2012-2013	6.3	75.3	-1.9	-2.2	2.5	**-0.5**	**+0.5**
2013-2014	5.9	77.0	-0.5	-0.6	1.0	**0.0**	**+1.0**
2014-2015	7.8	45.0	0.6	-1.4	2.1	**0.4**	**+1.4**

Table 2

Influence of the rainfalls from spring period concerning the attack of *T. dilaticollis* on maize untreated plants, at NARDI Fundulea (1984-2004)

Season	Atack intensity (1-9)	Saved plants (%)	Rainfalls (mm)						Total ammount (mm)	Deviation (mm)
			Curent year			Multiyear average				
			Apr.	May		Apr.	May			
			III	I	II	III	I	II		
1984	4.9	72.0	21.0	0.2	31.4	5.5	17.5	20.0	**52.6**	**+9.6**
1985	8.9	2.0	2.7	0	4.2	5.5	17.5	20.0	**6.9**	**-36.1**
1986	8.5	12.0	6.0	4.1	7.7	5.5	17.5	20.0	**17.8**	**-25.2**
1989	9.0	0	2.3	12.2	8.1	5.5	17.5	20.0	**22.6**	**-20.4**
1994	8.7	10.0	6.7	2.5	2.3	5.5	17.5	20.0	**11.5**	**-31.5**
1995	8.4	9.0	4.1	7.1	18.2	5.5	17.5	20.0	**29.4**	**-13.6**
1999	4.3	90.0	48.9	12.0	36.7	5.5	17.5	20.0	**97.6**	**+54.6**
2000	5.7	67.0	40.4	2.4	25.3	5.5	17.5	20.0	**68.1**	**+25.1**
2001	4.8	86.0	3.2	19.1	13.0	5.5	17.5	20.0	**35.3**	**-7.7**
2002	7.6	20.0	8.9	0	0.9	5.5	17.5	20.0	**9.8**	**-33.2**
2003	7.8	43.0	5.8	0.1	0	5.5	17.5	20.0	**5.9**	**-37.1**
2004	6.2	74.0	0.1	148.0	26.0	5.5	17.5	20.0	**174.1**	**+131.1**

Table 3

Influence of the rainfalls from spring period concerning the attack of *T. dilaticollis* on maize untreated plants, at NARDI Fundulea (2010-2015)

Season	Atack intensity (1-9)	Saved plants (%)	Rainfalls (mm)						Total ammount (mm)	Deviation (mm)
			Curent year			Multiyear average				
			Apr.	Mai		Apr.	Mai			
			III	I	II	III	I	II		
2010	5.1	85.5	4.4	2.6	13.3	5.5	17.5	20.0	**20.3**	**-22.7**
2011	5.8	79.3	2.1	48.4	23.0	5.5	17.5	20.0	**73.5**	**+30.5**
2012	6.7	68.2	1.8	14.2	87.8	5.5	17.5	20.0	**103.8**	**+60.8**
2013	6.3	75.3	0	5.8	11.4	5.5	17.5	20.0	**17.2**	**-25.8**
2014	5.9	77.0	12.7	21.5	57.1	5.5	17.5	20.0	**91.3**	**+48.3**
2015	7.8	45.0	10.4	8.0	2.4	5.5	17.5	20.0	**20.8**	**-22.2**

Table 4

Influence of the temperatures from spring period concerning the attack of *T. dilaticollis* on maize untreated plants, at NARDI Fundulea (2010-2015)

Season	Atack intensity (1-9)	Saved plants (%)	Temperature (°C)						Aveage (°C)	Deviation (°C)
			Curent year			Multiyear average				
			Apr.	Mai		Apr.	Mai			
			III	I	II	III	I	II		
2010	5.1	85.5	13.4	15.9	16.4	12.5	13.1	17.1	**15.2**	**+1.0**
2011	5.8	79.3	12.2	11.8	17.1	12.5	13.1	17.1	**13.7**	**-0.5**
2012	6.7	68.2	17.4	16.6	20.8	12.5	13.1	17.1	**18.3**	**+4.0**
2013	6.3	75.3	18.1	19.3	19.4	12.5	13.1	17.1	**18.9**	**+4.7**
2014	5.9	77.0	13.7	13.5	15.5	12.5	13.1	17.1	**14.2**	**0**
2015	7.8	45.0	12.6	17.4	18.7	12.5	13.1	17.1	**16.2**	**+2.0**

dilaticollis at maize untreated plants. Data from table 1 show that in last 10 days of the April and first 20 days of the May of the year 2012 it has registered 103.8 mm while in same period of the year 2014 it has registered 91.3 mm. This values exceeded multiyear averages. However in spring period of the 2012 it has registered high attack of maize leaf weevil at untreated plants (I=6.7) while in 2014 it has registered moderate attack (I=5.9). In 2010 it has registered low level of the rainfalls, in period of maize first vegetation stages (BBCH 10-14), but the attack of *T. dilaticollis* at maize untreated plants was low (I=5.1).

Analyzing data from table 4 it has ascertained that average temperature registered in spring period (last 10 days of the April and first 20 days of May) at NARDI Fundulea was higher then multiyear average in 2010, 2012, 2013 and 2015 and lower comparative with multiyear average in 2011. Year 2014 it was considered normal. In 2012 it has registered higher temperature differences comparative with multiyear average. Even if the rainfalls were higher comparative with average for this period, most of the rains occurred after maize arrive in four leaf stage and pest attack after this stage was less dangerous for plants. In previous studies we demonstrate that daily distribution of temperatures and rainfalls during period taken in study (last 10 days of April and first 20 days of May) have major influence concerning *T. dilaticollis* attack at maize plants (Georgescu E. *et al.,* 2014; 2015). These preliminary results of this study make in evidence that climatic conditions from winter period hasn't influence concerning maize leaf weevil attack in following spring. The most important are the climatic conditions from period when maize are in first vegetation stages (BBCH 10-14). Low rainfalls level and high temperatures from this period favor pest attack. However, further studies are necessary for better understanding of these aspects, in context of climate changes.

CONCLUSIONS

Temperatures registered during winter period have no influence concerning *T. dilaticollis* attack at maize untreated plants in next spring.

Rainfalls level and temperatures registered in period when maize plants are in first vegetation stages (BBCH 10-14) are very important for insect evolution.

High temperatures and low rainfalls level favor maize leaf weevil attack at maize plants.

In last years, temperatures registered during winters were higher then multiyear average.

In last years, climatic conditions from spring period were atypically.

REFERENCES

Antonie I., Stanciu M., Sand C., Blaj R., 2012 - *Theresearches regarding the biodiversity of the entomologic of the corn cultures in the Sibiu county*. Scientific Papers, Series Management, Economy. Engineering. in Agriculture and Rural Development, 12 (1):5-10.

Barbulescu A., 2001 - *Results obtained in year 2000, în frame of the researches concerning cereals, industrial and forages plants pest and diseases*. Problems of Plant Protection, 29 (2): 123-178.

Barbulescu A., Voinescu I., Sadagorschi D., Penescu A., Popov C., Vasilescu S., 2001 - *Cruieser 350 FS-A new product for maize and sunflower seed treatment against Tanymecus dilaticollis Gyll*, Romanian Agricultural Research, 15: 77-87.

Battisti A., Stasny M., Netherer S., Robinet C., Schph A., Roques A., Larsson S., 2005 - *Expansion of geographic range in the pine processionary moth caused by increased winter temperatures*. Ecological Aplications, 15 (6): 2084–2096.

Čamprag D., Jasnic, S., Sekulik, R., Matic, R., 1969 - *Harmfulness and control of Tanymecus dilaticollis Gyll. in corn*. Contemporary Agriculture, 17 (5/6): 261-268.

Čamprag D., 2007 - *Proliferation of field crop pests in Serbia and neighbouring countries in the 20th century (Razmnozavanje štetočina ratarskih kultura u Srbiji i susednim zemljama tokom 20. veka.)*, 348 pp.

Čamprag D., 2011 - *Impact of climate to appearance of field crop pests in Vojvodina [Serbia] during 2001-2020 [i.e. 2010]*. Biljni lekar, 39(4):434-446.

Cristea M., Cabulea I., Sarca T., 2004 - *Maize. Monograph study, Vol.* 1. Romanian Academy Publishing house, Chap. 14, 589-626.

Daniel P.B., Ramotowski M.A.T., Gurr S.J., 2013 - *Crop pests and pathogens move polewards in a warming world*. Nature Climate Change, 3:985–988.

Diffenbaugh N.S., Krupke C.H., White M.A., Alexander C.A., 2008 - *Global warming presents new challenges for maize pest management*. Environmental Research Letters, 3 (4):1-9.

Georgescu E., Cana L., Gargarita R., Voinea L, Rasnoveanu L., 2015 - *Atypically Behavior of the Maize Leaf Weevil (Tanymecus Dilaticollis Gyll) on Maize and Sunflower Crops, in Climatic Conditions of the Year 2014, in South-East of Romania*, Agriculture and Agricultural Science Procedia, 6:9-16.

Georgescu E., Toader M., Cana L., Gargarita R., 2014 - *Draught influence concerning maize leaf weevil (Tanymecus dilaticollis Gyll) attack on maize crops at NARDI Fundulea*, Scientific Papers, Series A Agronomy, Vol. 57:186-191.

Hakala K., Hannukkala A.O., Huusela-Veistola E., 2011 - *Pests and diseases in a changing climate a major challenge for Finnish crop production*. Agricultural and Food Science, 20(1):3-14.

Ju H., Van der Velde M., Erda L., Xiong W., Yingchun, 2013 - *The impacts of climate change on agricultural production systems in China*, Climate Change, 120(1):313-324.

Karuppaiah V., Sujayanad G. K., 2012 - *Impact of Climate Change on Population Dynamics of Insect Pests*. World Journal of Agricultural Sciences, 8 (3):240-246.

Luterbacher J., Dietrich D., Xoplaki E., Grosjean M., Wanner H., 2004 - *European Seasonal and Annual Temperature Variability, Trends, and Extremes Since 1500*. Science, 303 (5663): 1499-1503.

Maxem A., 2013 - *Crop pests: Under attack*. Nature, 501:S15–S17.

Oakley J.N., 2008 - *Control needs for changing pest distributions*. HGCA conference 'Arable cropping in a changing climate', 87-92.

Olesen, J.E., Tmka, M., Kersebaumc, K.C., Skjelvågd, A.O., Seguine, B., Peltonen-Sainiof, P., Rossig, F., Kozyrah, J., Micalei, F., 2011 - *Impacts and adaptation of European crop production systems to climate ch*ange. European Journal of Agronomy, 34 (2): 96-112.

Paulian F., Popov C., Dinu-Pana M., 1969 - *The corn leaf weevil (Tanymecus dillaticolis Gyll.) in Romania and its control*. Contemporary Agriculture, Yugoslavia, Novi Sad, 5-6:643-652.

Paulian F., 1972 - *Contribution at knowledge of the development, ecology and control of the Tanymecus dilaticollis specie*. Doctoral thesis, I.A.N.B. Bucharest, pp. 300.

Paulian F., Ciurdarescu G., Mateias M.C., Brudea V., Caea D., Ignatescu I., Perju T., Peteanu S., Sapunaru T., Sandru I., 1974 - *Actual problems concerning diseases and pest of the forages*. Problems of Plant Protection, 2 (1):76-109.

Popov C., 2002 - *Researches concerning the protection of the cereals, leguminosae for grains, technical and forage plants against pathogen agents and pests, year 2001*. Problems of Plant Protection, 30 (2):109-190.

Popov C., Barbulescu A., Guran, M., Raranciuc S., Spiridon C., Vasilescu S., Valsan D., Mateias M.C., Voinescu I., 2002 - *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2001*. Problems of Plant Protection, 30 (1):1-21.

Popov C., Guran M., Raranciuc S., Rotarescu M., Spiridon C., Vasilescu S., Gogu F., 2003 - *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania, in 2002*. Problems of Plant Protection, 31(1):1-22.

Popov C., Guran M., Raranciuc S., Rotarescu M., Spiridon C., Vasilescu S., Gogu F., 2004 - *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2003*. Problems of Plant Protection, 32(1):1-23.

Popov C., Guran M., Raranciuc S., Rotarescu M., Spiridon C., Vasilescu S., Gogu F., 2005 - *Phytosanitary state of cereals, leguminous for grain, industrial and fodder crops in Romania in 2004*. Problems of Plant Protection, 33(1-2):7-29.

Popov C., Trotus E., Vasilescu S., Barbulescu A., Rasnoveanu L., 2006 - *Drought effect on pest attack in field crops*. Romanian Agricultural Research, 23:43-52.

Popov C., Barbulescu A., 2007 - *50 years of scientific activity în field crop protection area, against pests and siseases*, Anals of NARDI Fundulea, 75:371-404.

Popov C., Barbulescu A., Raranciuc S., 2007 - *Seed treatment a modern, efficient and less pollutant method for field crops protection*, Annals of N.A.R.D.I. Fundulea, 75:133-139.

Rosca I., Rada I., 2009 - *Entomology (Agriculture, Horticulture, Forest)*. Alpha MDN Publishing house, 699 pp. (Cap. II: 119-141).

Rosenzweig C., Iglesias A., Yang X.B., Epstein P.R., Chivian, E., 2001 - *Climate Change and Extreme Weather Events; Implications for Food Production*. Plant Diseases, and Pests. Global Change and Human Health, 2 (2):90-104.

Trotus E., Buburuz A.A., Zaharia P., 2011 - *Researches on the protection of maize crops against soil pests*. Agronomical Researches in Moldavia, 4:45-51.

Trotus E., Zaharia P., Nae M., Buburuz A.A., Pochiscanu S.F., 2013 - *Research on the evolution of Agrotis segetum Den. et Schiff. species under conditions of central Moldavia*. Annals of NARDI Fundulea, 81:141-153.

Wolfe D.W., Ziska L., Petzoldt C., Seaman A., Chase L., Hayhoe K., 2007 - *Projected change in climate thresholds in the Northeastern U.S.: implications for crops, pests, livestock, and farmers*. Mitigation and Adaptation Strategies for Global Change, 13(5):555-575.

*****Rich Harvests, 2013** - *Farmer profile*, 152:26-27.

*****Rich Harvests, 2014** - *We buy now, we pay at……harvest*, 156:20-21.

*****Plants Health, 2015 -** *Massive attack of Tanymecus dilaticollis in Romania*. 205:1-2.

*****EUROSTAT database, 2015** - http://ec.europa.eu/eurostat/data/database

*****MADR data, 2015 -** http://www.madr.ro/culturi-de-camp/cereale/porumb.html